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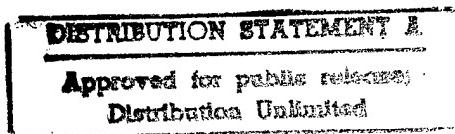
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Science & Technology

USSR: Materials Science



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JPRS-UMS-88-011

8 JULY 1988

SCIENCE & TECHNOLOGY
USSR: MATERIALS SCIENCE

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ANALYSIS, TESTING

UDC 620.251.2

Crack Resistance and Fracture Micromechanisms of Dispersion Hardened Alloy of Molybdenum With 30% Tungsten

18420224a Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 88 (manuscript received 25 Jun 87) pp 20-21

[Article by A. V. Babak, Ye. Ye. Gopkalo, G. H. Nadezhdin and Ye. I. Uskov, Strength Problems Institute, Ukrainian Academy of Sciences]

[Abstract] A study was made of the influence of temperature on the crack resistance and the microscopic mechanisms of fracture of dispersion-hardened molybdenum alloy with 30% tungsten in the 293-2073 K temperature range. Specimens $6.5 \cdot 10^{-3}$ m thick were cut from a hydraulically extruded bar so that the direction of the initial crack was the same as the direction of extrusion. Crack resistance increased with temperature. The micromechanism of rupture changed at 1873 K, with main cracks developing brittlely, primarily along grain boundaries, and second phase particles precipitating along grain boundaries, causing a decrease in crack resistance above 1873 K. References 7: 6 Russian, 1 Western (in Russian translation).

6508/9835

UDC 539.37.669.018.2

Influence of Deformation Rate on Reversible Shape Memory of Titanium Nickelide

18420224b Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 88 (manuscript received 25 Mar 86) pp 65-68

[Article by V. A. Likhachev and S. R. Shimanskiy, Leningrad State University]

[Abstract] A study is made of the kinetics of the appearance of reversible shape memory following deformation of equiaatomic TiNi alloy at dynamic and quasistatic rates. The influence of reversible shape memory on the shape memory effect is also studied. Specimens were cut from 1 mm sheets rolled

at 700-800 K and annealed at 720 K for 1 hour. Reversible shape memory produced by dynamic loading was found to be more resistant to subsequent stress in the opposite direction than that produced by quasistatic loading. References 6: 3 Russian, 3 Western (1 in Russian translation).

6508/9835

UDC 539.374

Calculation-Experimental Study of Thermal Fatigue of Gas Turbine Blades

18420224c Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 88 (manuscript received 05 Mar 86) pp 75-80

[Article by V. P. Trushechkin and M. Ye. Kolotnikov, All-Union Heat Engineering Institute]

[Abstract] The convective-film cooling apertures in gas turbine blades act as stress concentrator , decreasing the fatigue strength of the blades. This article reports on a calculation-experimental study of the thermal fatigue of blades under various loading conditions, differing in heating rate, cooling intensity and holding time at the maximum cycle temperature. The variation in durabilities of the blades was found to result from variations in long term strength and low-cycle thermal fatigue strength. It is suggested that coefficients considering the concentration of deformations around the cooling aperatures be introduced into the equations used to calculate the stress-strain state of the blades, in order to investigate the kinetics of deformation and the accumulation of damage in the area of the concentrators. References 4: all Russian.

6508/9835

UDC 539.37

Bending of Metal Plates Under Load Caused by Explosion of a Concentrated Explosive Charge

18420224f Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 88 (manuscript received 20 Jan 86) pp 112-114

[Article by G. V. Stepanov, A. V. Kovalenko, V. A. Maltsev, and P. V. Loshkomoyev, Strength Problems Institute, Ukrainian Academy of Sciences; ANTIM Scientific-Production Association]

[Abstract] A study is made of the explosive bending of circular steel plates with contours clamped, loaded by detonation of a concentrated explosive charge at some distance above the center of the plate. The

plates were 0.9 and 1.4 m in diameter, 5 and 10 mm in thickness, made of sheet steel as delivered and tested with a charge of ammonite (specific yield $4316 \cdot 10^3$ J/kg, density 900 kg/m^3 , suspended 100 and 200 mm correspondingly above the centers of the 5 and 10 mm plates. The pressure at the leading edge of the incident blast wave was more than 30 atmospheres. An approximate energy method of calculation is recommended to estimate the bending of the circular plate under the experimental conditions. Satisfactory agreement between calculated and experimental data is achieved. References 5: 2 Russian, 3 Western (1 in Russian translation).

6508/9835

UDC 669.14:44:620.172.4

Crack Formation During Long-Term Operation of Turbine Castings

18420224g Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 88 (manuscript received 16 Jun 86) pp 114-116

[Article by L. D. Mishchenko, I. N. Pisanenko, V. P. Tarabanova and S. S. Dyachenko, Kharkov Motor Vehicles and Highways Institute]

[Abstract] Steam turbine stop valve body castings of type 15Kh1M1FL steel with a mass of 10 tons were investigated after the valves had been in use for 95,000 hours at 540-550 C steam temperature, steam pressure 13 MPa, with a total of 558 turbine start ups, averaging 35 per year. A study of the metal structure near the cracks formed during operation revealed structural changes due to the high temepratures and stresses, including regeneration of beinite and segregation of ferrite sections near cracks. Rather large casting defects were observed, which were generally not the sources of the cracks. Microhardness was found to decrease near cracks. Changes in grain size and orientation and migration of grain boundaries were observed near cracks; wedge-shaped and oval microcracks were observed around grain boundaries. The structural heterogeneity resulted in the formation of areas of nonuniform deformation and recrystallization, between which cracks most frequently appear. The combination of grain boundary alterations and stress concentrators frequently caused the appearance of cracks.

6508/9835

UDC 621.165.539.319

Calculation Models and Calculation-Experimental Study of the Stress-Strain State of Turbine Bodies and Vessels Reinforced With Meridional Ribs

18420224h Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 88 (manuscript received 5 Aug 85) pp 123-124

[Article by V. I. Berlyand, N. M. Vrazhkin, G. M. Mellerovich, S. S. Sokolovskaya and V. P. Ukarov]

[Abstract] Two calculation models are discussed for consideration of the effect of meridional ribs on the strength of vessels. According to the first and more traditional model, the meridional ribs are considered as curved rods in contact with the inner or outer shell wall surface. The conditions of continuity of displacement are met along the line of intersection of the wall surface with the rib, and the unknown contact conditions are considered distributed through the width of the contact strip according to an a priori rule. The second model is an extension of an approach to computation of ribbed shells, according to which the meridional ribs are looked upon as sections with a sudden change in wall thickness of the shell, to the case of consideration of the physical nonlinearity of the material. Both of these approaches are found to yield satisfactory agreement with experimental results. References 5: 4 Russian, 1 Ukrainian.

6508/9835

UDC 621.762:539.4

Strength of Porous Sheet Sintered Materials

18420225c Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 88 (manuscript received 31 May 84) pp 92-96

[Article by V. K. Sorokin, Gorkiy Polytechnical Institute]

[Abstract] A study is made of the strength and ductility in bend tests of porous sheet materials produced by rolling and sintering of PKh18N15 stainless steel and titanium powders. Several experiments were performed on sheets of powdered nichrome Kh20N80 and a mixture of 75% electrolytic and 25% carbonyl nickel powders. Tensile strength and ductility in bending were determined on flat 10x50 mm specimens cut from the porous sheets, which were 0.13 to 0.53 mm thick. The shape of the pores was found to influence strength significantly. Equations are presented relating the tensile strength of the specimens to relative porosity. The thinnest sheets are rolled from powders of smaller diameter and can withstand a greater number of bends. References 10: all Russian.

6508/9835

UDC 669.3'787'893'794:539.32

Elastic Properties of $\text{YBa}_2\text{Cu}_3\text{O}_{7+\delta}$ at 4.2-300K

18420223a Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian No 2,
Feb 88 (manuscript received 31 Jul 87) pp 397-398

[Article by Ya. N. Blinovskov, A. M. Burkhanov, V. V. Gudkov, I. V. Zhevstovskikh, V. L. Kozhevnikov, I. A. Leonidov, A. V. Tkach, V. V. Ustinov, and S. M. Cheshnitskiy, Metal Physics Institute, Urals (UrO) Department, USSR Academy of Sciences; Chemistry Institute, Urals Department, USSR Academy of Sciences]

[Abstract] A study is made of the elastic properties of the ceramic $\text{YBa}_2\text{Cu}_3\text{O}_{7+\delta}$ over a broad temperature range to determine anomalies related to the superconducting transition and other phase transitions. The specimen, synthesized at 940-960C by standard ceramic techniques, had superconducting transition temperature $T_c = 92.7\text{K}$, $\Delta T_c = 1.4\text{K}$, $P_{100\text{K}} = 0.4 \text{ m Ohm}\cdot\text{cm}^{-1}$. Ultrasonic studies were performed by measurement of the resonant frequency and Q of the system consisting of the specimen with a piezoelectric converter glued to it. The curves of $\Delta v/v$ show a singularity at 230K. Temperature hysteresis of the speed of sound was observed at 5-210K. The hysteresis loop shifted slightly upon repeated temperature cycling. Heat treatment at 200C almost eliminated the hysteresis and the peaks on the curves of Q^{-1} at 60 and 230K, the speed of sound at 275K changing from 1828 to 1948m/s. These changes may have been related to a loss of oxygen or its redistribution in the specimen. References 3: all Russian.

6508/9835

UDC 669.35'787:535.33/.34

X-Ray K Emission and Absorption Spectra of Copper in Binary Oxides and High-Temperature Superconductors

18420223b Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian No 2, Feb 88 (manuscript received 1 Sep 87) pp 399-400

[Article by V. I. Glazyrina, N. N. Yefremova, M. A. Korotin, E. Z. Kurmayev, L. D. Finkelstejn and Yu. M. Yarmoshenko, Metal Physics Institute, Urals Department (UrO), USSR Academy of Sciences]

[Abstract] K-emission and K-absorption spectra of copper were studied in simple oxides and $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ and YBa_2CuO_7 on x-ray spectrometers with position-sensitive detectors and an energy resolution of about 2eV. The major changes in the absorption spectra were observed in the area of the initial absorption. The K_{35} emission spectra of the copper in the oxides studied consist of three broad overlapping bands, two resulting from hybridization of 4p copper electrons with the valent electrons of oxygen in the first coordination sphere of the copper atoms. The central band results from

hybridization of Cu4p electrons with the major valent 2p electrons of oxygen. There is an increase the half width of the K₈₅ spectrum and its integral intensity upon transition from simple oxides to more complex ones, which may be explained as an increase in the number of binding electrons and a decrease in self absorption. Thermogravimetric analysis of La_{2-x}Sr_xCu₄ showed a decrease in oxygen content with increasing x. References 6: 3 Russian, 3 Western.

6508/9835

UDC (546.562+537.312.62):537.311.6

Specifics of Field and Temperature Variations of Surface Impedance of High Temperature Superconductors La_{1.8}Sr_{0.2}CuO₄ and YBa₂Cu₃O₇ Below T_c

18420223c Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian No 2, Feb 88 (manuscript received 14 Sep 87) pp. 401-402

[Article by Yu. N. Shvachko, A. A. Romanyukha, A. P. Stepanov, V. L. Kozhevnikov and S. M. Cheshnitskiy, Metal Physics Institute, Urals Department (UrO), USSR Academy of Sciences]

[Abstract] A study is presented of the electrodynamic properties of high-temperature superconductors below the superconducting transition point in the presence of a magnetic field. Polycrystalline specimens of La_{1.8}Sr_{0.2}CuO₄ with T_c = 30K and YBa₂Cu₃O₇ with T_c = 87K measuring 1x1x2mm were tested in the 3 centimeter band. An additive contribution to surface impedance was observed in both compositions, depending on the direction of the scan of the magnetic field. The break on the curve of δ(T) contradicts the previously accepted theory. The existence of the Δz contribution which appears between H_{c1} and H_{c2} allows the method of this article to be used to estimate H_{c1} and H_{c2}. References 4: 1 Russian, 3 Western.

6508/9835

FERROUS METALS

UDC 669.14.018.252.3:621.546.543

Structure and Properties of Molybdenum-Vanadium High-Speed Steel With Aluminum

18420219a Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 1, Jan 88 (manuscript received 21 Apr 87) pp 101-105

[Article by A. N. Popandopulo, Ko Men Chkhor and N. V. Tsvetova, Leningrad Polytechnical Institute]

[Abstract] A study was made of molybdenum-vanadium high-speed steel type MSF3SYu containing 1.3% C, 4% Cr, 5% Mo, 3% V, 0.6% Si and 0.7% Al. Bars of hot-rolled steel 50 mm in diameter were forged to 8x8 mm squares and annealed for 1.5 hours at 840C, then cooled to 720C at 40 C/hr, held 4 hours, cooled to 600C with the furnace, then in air. The annealed blanks were used to make specimens which were hardened, tempered and mechanically tested. The phase composition was studied on an x-ray installation and microscopic x-ray spectral instrument. The aluminum was found to increase the red hardness of the steel by increasing the thermodynamic activity of the carbon and other alloying elements in the austenite, accelerating the ascending diffusion of the elements to the grain boundaries and hardening them due to the grain-boundary carbide segregations during hardening and tempering. Maximum alloy element content is achieved after hardening from 1160C with small grain austenite. Hardening from 1240C results in an increase in grain size and a reduction in total Mo+V+Cr in the solid solution, hardening of grain boundaries due to formation of a carbide framework and an increase in secondary hardness and red hardness, but a decrease in strength and ductility. References 12: all Russian.

6508/9835

UDC 669.14.018.6

Influence of Scandium on Properties of 35KhGSL Steel in Liquid and Solid States

18420219b Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 1, Jan 88 (manuscript received 21 Jan 87) pp 105-108

[Article by I. N. Igoshin, Yu. A. Bazin, B. A. Baum, G. A. Raspopova and B. P. Domashnikov, Urals Polytechnical Institute]

[Abstract] A study is presented of the possibility of microalloying 35KhGSL steel with scandium in order to improve its usage properties. The structural parameters studied, including the volumetric fraction of nonmetallic inclusions, ferrite and beinite in a pearlite matrix, indicate that steel with 0.1% Sc should have the maximum ductility. The influence of scandium on the kinematic viscosity of the liquid steel, as well as the structure and usage properties of the solid specimens, is found to be nonmonotonic. A correlation is observed between the change in the properties of the steel in the liquid and solid states. The improvement in usage characteristics of the steel under the influence of scandium results from an increase in the homogeneity of the melt, a change in the number and shape of nonmetallic inclusions, and the more homogeneous structure of the solid specimens.

References 6: all Russian.

6508/9835

UDC 669.14.018:252.3:621.305.826

Experimental Construction of Laser Hardening Diagrams of Tool Steel

18420219c Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 1, Jan 88 (manuscript received 29 Aug 86) pp 116-121

[Article by V. A. Burakov, Rostov-On-Don Plant-VTUZ under the Rostselmash Production Association]

[Abstract] Specimens of steels designed for the manufacture of stamping dies and cutting tools were subjected to hardening and low tempering by the method traditional for each type of steel. Surface roughness was reduced by grinding, and the specimens were etched for 20-30s in an alcohol solution of picric acid. Specimens were treated with a pulsed laser in the free generation mode, pulse length 1-10ms, pulse energy not over 30J. Processes of dissolution of excess carbides plus processes of homogenization were found to develop primarily as the steel was melted. Laser hardening diagrams were constructed showing the critical modes at which austenitization, melting or evaporation begins, as well as the maximum depths to which they extend, creating conditions for subsequent hardening. The diagram allows reliable

and rapid determination of the proper modes for treatment of tools to provide guaranteed levels of properties of the working edges. References 5: 3 Russian, 2 Western (1 in Russian translation).

6508/9835

UDC 669.046.558.5:620.17

Increasing Impact Toughness of Carbon Steel by Selenium and Tellurium Modification

18420219d Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 1, Jan 88 (manuscript received 10 Aug 87)
pp 167-168

[Article by M. I. Gasik, Ch. D. Ismailov and Yu. S. Proydak, Dnepropetrovsk Metallurgical Institute]

[Abstract] Results are presented from pilot-scale studies of the influence of the addition of small quantities of selenium and tellurium (0.005% each) on the properties of carbon steel produced in an open-hearth furnace for production of railroad wheels. Final deoxidation of the metal was performed in the ladle by silicon-calcium (1.3 kg/t). The steel was poured by siphon and modified in the mold with ferroselenium and ferrotellurium. An increase in impact toughness of 15-25% was observed at +20°C and by 2 to 5 times at temperatures below freezing. Ductility was increased by 15-40% while strength properties were practically identical. Modification with selenium or tellurium this increases impact toughness and ductility while retaining satisfactory strength. References 5: all Russian.

6508/9835

NONFERROUS METALS, ALLOYS, BRAZES, SOLDERS

UDC 620.193.01

Electrochemical Behavior of Transition Metals and Refractory Compounds of Titanium in Synthetic Sea Water

18420225a Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 88
(manuscript received 3 Apr 86) pp 81-87

[Article by A. D. Verkhoturov, M. A. Kuznekova, N. V. Lebukhova and I. A. Podchernyayeva, Mining Institute, Far Eastern Scientific Center, USSR Academy of Sciences]

[Abstract] The corrosion-electrochemical behavior of compounds of titanium with boron, carbon, nitrogen and, for comparison, transition metals as model objects was studied in synthetic sea water at pH8, 22°C. The electrochemical study of the metals was performed on foil specimens of 99.999% purity, as well as technical titanium and molybdenum with 99.99% purity. Anodic polarization curves were obtained by a potentiodynamic method with potential change rate of 0.33 mV/s. The pitting formation potential was determined by observing the increase in current with anodic polarization of specimens in sea water with a gradual change in E. All of the materials studied except W and Mo were in the passive state in sea water. The results indicated that titanium has the greatest corrosion resistance in sea water of all transition metals, due to the formation of an anodic oxide film of TiO_2 with very low electron conductivity preventing reactions liberating oxygen on the surface of the specimens. The corrosion behavior of titanium nitride was comparable to that of such transition metals as Ti, Nb and Ta, which are not inclined to pitting corrosion. The porosity of titanium nitride reduces the protective effect of the surface layer and facilitates oxidation and pitting. Titanium nitride is superior to titanium carbide in its corrosion resistance, which in turn is superior to titanium diboride. References 12: 11 Russian, 1 Western.

6508/9835

UDC 022.346.3

Change in Phase Composition and Stress State of Hard Alloy VK20 Surface Layers After Ion Bombardment

18420 225b Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 88
(manuscript received 25 Feb 87) pp 87-89

[Article by G. L. Platonov, Ye. Yu. Leonov, V. N. Anikin and A. I. Anikeyev,
All-Union Scientific Research Institute of Refractory Metals and Hard Alloys]

[Abstract] A study is made of the change in structure, composition and stress state of the surface layers of the hard alloy VK20 following bombardment with titanium ions on an installation designed for application of coatings by condensation with ion bombardment. Pressure in the operating chamber was $5 \cdot 10^{-3}$ Pa, current of the arc used to evaporate the titanium cathode 100A, potential on hard alloy plates 1.1 kV, ion bombardment time 1 and 5 minutes. The microstructure of the alloy was studied metallographically on a light microscope and by x-ray diffraction. The studies established that the bombardment formed a layer of η -phase 1 - 2 microns thick with the composition $\text{Co}_6\text{W}_6\text{C}$. Microscopic x-ray spectral analysis of the surface revealed titanium in the form of the carbide. The x-ray studies showed that the bombardment of the alloy resulted in an increase in the absolute value of total stresses perpendicular to the surface of the alloy and a decrease in stresses parallel to the surface. Cobalt near the surface remained in the α form. The $\text{Co}_6\text{W}_6\text{C}$ and titanium carbide are formed by diffusion of carbon from the alloy at the high temperatures in the bombarded zone. References 8: 3 Russian, 5 Western.

6508/9835

NONMETALLIC MATERIALS

UDC (546.562+537.312.62):537.311.3

Anomalies of Resistance of Ceramics in the Y-Ba-Cu-O System

18420223d Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian No 2,
Feb 88 (manuscript received 5 Oct 87) pp 402-404

[Article by B. B. Boyko, A. I. Akimov, V. I. Gatalskaya, S. Ye. Demyanov,
L. A. Kurochkin, M. L. Petrovskiy, Ye. K. Stribuk and V. M. Finskaya,
Solid-State and Semiconductor Physics Institute]

[Abstract] In the process of the investigation of high temperature superconducting ceramics, the authors synthesized compositions which had typical superconducting transitions at 90-100K plus unusual behavior at higher temperatures. Ceramic specimens in the Y-Ba-Cu-O system were manufactured by the ordinary ceramic techniques of synthesis in air at 950C and ground and pressed into disks at 500 atmospheres. Annealing was performed for five hours at 950-1050C and specimens cut for dc resistance measurements. The average resistance at room temperature was 0.1 Ohm. In addition to the normal 90-100K superconducting transition, anomalous resistance behavior of several specimens of the ceramic $Y_1Ba_2Cu_3O_7$ was observed immediately after preparation of the material, with a sharp drop in resistance with temperature, by two orders of magnitude, with a minimum at 193K, below which temperature the resistance increased. After four to five times of thermal cycling at 293-77K, the shape of the temperature variation of resistance changed, the anomaly at 193K disappearing and the change in resistance with temperature taking on the nature of a metal with a transition to the superconducting state and zero resistance at 82.7K. References 9:
1 Russian, 8 Western.

6508/9835

Synthesis of Diamonds in Graphite - Metal Hydrides Systems

18420222a Kiev SVERKHTVERDYYE MATERIALY in Russian No 1, Jan-Feb 88
(manuscript received 7 May 86) pp 3-4

[Article by L. F. Kulikova, M. D. Shalimov, V. N. Slesarev and Ye. N. Yakovlev, Troitsk, Moscow Oblast; High Pressure Physics Institute, USSR Academy of Sciences]

[Abstract] Diamonds can be produced from hydrocarbons and carbohydrates under high pressures. The first stage of the process in either case is the thermal destruction of the organic compounds with the formation of simple C_nH_m dioxide and water in the synthesis of diamonds from carbohydrates. Carbon and hydrogen are present in the reaction zone in both processes, but the hydrogen's role is not clear. Therefore a study was made of the behavior of a carbon material in a hydrogen system under conditions for the synthesis of diamonds from organic compounds. Metal hydrides that dissociate at high pressures and temperatures provided the hydrogen and their use eliminated the presence of the other gaseous compounds names. Toroidal chambers were used in the experiments with catlinite as the pressure-transferring medium. The temperature was estimated by means of Chrmel-Alumel and platinum - platinum-rhodium thermocouples. Calcium hydride and lithium hydride were put between layers of graphite in a graphite container that served as the heater. Diamonds were produced having an average grain size of 0.5 to 1 micrometer with regions of single crystals with dimensions reaching 10 to 15 micrometers. The diamonds were aggregations of lamellar and, less frequently, octahedral crystals with primarily a grayish color. Electron microscope, x-ray micro-analysis and x-ray phase analysis studies were conducted. The diamonds were resistant to oxidation in air to 740°C. A control experiment conducted under identical conditions but with the absence of hydrides resulted in the formation of no diamonds. It is concluded that the presence of hydrogen in the reaction zone stimulates the formation of diamonds. References 3: all Russian.

8831/9835

Oxidation of Sintered Ceramic Based on Silicon Nitride with Titanium Carbonitride and Zirconium Nitride Impurities

18420222b Kiev SVERKHTVERDYYE MATERIALY in Russian No 1, Jan-Feb 88
(manuscript received 24 Dec 86) pp 27-33

[Article by Yu. G. Gogotsi, V. K. Kazakov V. A. Lavrenko, T. G. Protsenko and V. V. Shvayko, Kiev; Institute of Materials Science Problems, Ukrainian SSR Academy of Sciences, Superhard Materials Institute, Ukrainian SSR Academy of Sciences, and Kiev Polytechnical Institute]

[Abstract] The addition to materials based on silicon nitride of other high-melting compounds is conducive to enhanced hardness, crack resistance and strength and to activation of the sintering process, but can at the same time result in reduced heat resistance. A study was made of the kinetics of the oxidation in air at temperatures to 1400°C of ceramics with zirconium nitride and titanium carbonitride impurities uniformly distributed over a silicon nitride matrix. Specimens were produced by free sintering in argon. The oxidation process was studied with a OD-103 derivative polarograph under isothermal conditions by the method of periodic weighing and with programmed heating at a rate of 15°C per minute. The DRON-2,0 diffractometer was used to make an x-ray phase analysis of the oxidation products and the Super Probe 733 electron probe was used for electron microscope studies. The specimens measured 5 x 5 x 10 mm. It was found that materials with a ZrN impurity are least resistant to oxidation. Their high porosity results in the fact that the silicon nitride skeleton does not play the expected protective role. More than 80 percent of the ZrN contained in the specimen oxidizes when heated to 700°C under nonisothermal conditions, and this is conductive to cracking of the specimen on account of the internal stresses originating as ZrN is transformed into ZrO₂. Complete failure of the specimens occurred after being held at 800°C for 15 minutes. The oxidation of specimens with a titanium carbonitride impurity began at approximately 380°C, resulting in the formation of TiO₂. Cracking of specimens with a titanium carbonitride impurity was not observed in oxidation. The oxidation of TiC_{0.5}N_{0.5} takes place more slowly than that of ZrN. The active oxidation of titanium carbonitride and zirconium nitride impurities in sintered porous materials based on silicon nitride results in the poor resistance of these ceramics to oxidation. The presence of a ZrN impurity makes them unsuitable at high temperatures. Those having a titanium carbonitride impurity can be used at temperatures of 100 to 1400°C, but when used in the temperature range of 400 to 900° they must be preoxidized at higher temperatures in order to form a protective oxide film on their surface. The addition of aluminum oxide results in a sharp increase in density and resistance to oxidation. References 9: 7 Russian, 2 Western.

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Frequency Characteristics of Diamond Ceramic Containing Titanium Disilicide

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(manuscript received 29 Sep 86) pp 33-36

[Article by A. V. Bogdanov, Kherson, and I. M. Vikulin, Odessa; Kherson Industrial Institute and Odessa Electrical Engineering Institute of Communications]

[Abstract]. Results are presented of a study of the frequency characteristics of a diamond ceramic having inductive impedance, i.e., its conductance is lowered with an increase in alternating-current frequency. The ceramic is composed of diamond powder, 24 to 30 percent by weight of $TiSi_2$ and 10 percent by weight of borax. The borax serves as a binder and the titanium disilicide lowers the ceramic's electrical resistance so that it can be used for making electronic devices like varistors. Specimens were prepared according to a method described elsewhere and measured 12 mm in diameter and 2 mm thick. The Schoop process was used to apply aluminum terminals, which penetrated to a depth equal to the size of dozens of grains of the starting powders, thus eliminating the possibility of the terminals' influencing the ceramic's conductance. The temperature of the specimens was varied from 300 to 900 K when measuring direct- and alternating-current conductance. Current and voltage were measured with a V7-27A digital voltmeter and the ISN-1 instrument served as the power supply. Under low voltage (10 V) and at relatively low temperatures of 300 and 600 K the conductance of specimens consisting of 65 percent diamond, 25 percent $TiSi_2$ and 10 percent borax and having a powder particle size of one micrometer increases with an increase in alternating-current frequency, but it drops at 700 K under voltage of 100 V, i.e., inductive impedance is observed. The electrical resistance of the TiS_2 grains together with the oxide film coating them is considerably lower than that of the diamond and is determined largely by the conditions under which the specimens are annealed. The mechanism for the formation of inductive impedance in a diamond ceramic is discussed, based on the flow theory described elsewhere. A flow threshold is observed when the low-impedance component occupies 25 percent of the specimen's volume. The length of current-conducting channels increases in the high-impedance material with a threshold concentration of the low-impedance component. A formula is presented for calculating the inductance of two random current-conducting channels having a given radius and distance between them. Under certain conditions the inductance in specimens of the material studied can reach thousands of henries. An equivalent circuit is presented in order to explain the experimental results. The inductive impedance observed in the diamond ceramic studied can be explained by the electromagnetic interaction of current-conducting channels when the ceramic contains 25 percent titanium disilicide by weight. References 5: 4 Russian, 1 Western (in Russian translation).

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WELDING, BRAZING, SOLDERING

UDC 539.4:621.396

Influence of Protective Polymer Coating on Strength of Fiber Light Guides of Chalcogenide Glasses

18420224e Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 88 (manuscript received 24 Nov 86) pp 109-111

[Article by A. F. Shchurov, A. M. Shirayev, I. V. Skripachev, V. A. Shipunov and M. A. Tselovalnikova, Gorkiy State University]

[Abstract] A study is made of the strength characteristics of fiber light guides of chalcogenide glasses $Ge_5As_{38}Se_{57}$ and $Ge_5As_{38}S_{57}$ with protective polymer coating applied from solution at low temperature. Comparative strength and crack resistance testing of the light guides with and without the coating showed that the coating significantly strengthened the light guides, probably because the coated guides were less exposed to random external factors which could cause defects on the surface, which have been found to have a dominant influence on the strength of the light guides. The increase in crack resistance is not related to any structural changes in the glass, but rather is caused by an increase in the hardening of the glass fiber as the polymer coating is applied due to the increase in cooling rate of the glass in contact with the polymer solution, and by the reinforcement of surface defects by the polymer coating. Penetration of the polymer into a crack partially unloads the crack, increasing the resistance to crack propagation. Mean strength was increased by a factor of 2.5-3 by the application of the polymer coating. References 5: 4 Russian, 1 Western.

6508/9835

UDC 621.797.3:624.074:666.1

Serviceability of Shells of Glass and Ceramic With Soldered Joints Exposed To External Pressure and Marine Conditions

18420224d Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 88 (manuscript received 2 Mar 87) pp 95-101

[Article by Yu. N. Yevplov, G. M. Okhrimenko, Yu. M. Rodichev and I. I. Gab, Strength Problems Institute, Ukrainian Academy of Sciences]

[Abstract] Experimental technological processes were developed for soldering of glass and porcelain shells using metal solders, and the serviceability of the shells was studied when exposed to external pressure and marine conditions. Four methods were used: 1) soldering with strip solder; 2) soldering with preliminary metallization of the surfaces with tin; 3) soldering with paste solder, without preliminary metallization, and 4) soldering with contact solder in feeders. The tensile strength of the brittle materials was reduced in the area of the solder joints by factors of 2.5-3, probably due to the high temperature of the soldering process. Soldering methods 3 and 4 yielded higher strength joints in glass than the other two. However, none of the methods yielded joints which were stronger than glued joints or more corrosion resistant in sea water. References 8: 7 Russian, 1 Western.

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